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Docket No. TIP346US TI-37151

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re **PATENT** application of:

Applicant:	Glen R. Fox et al.
Application No.:	10/797,503
For:	OPTIMIZED PZT CRYSTALLOGRAPHIC TEXTURE FOR ENHANCED HIGH DENSITY FRAM
Filing Date:	March 10, 2004
Examiner:	Ahmed N. Sefer
Art Unit:	2826

APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicants submit this brief in connection with the appeal of the above-identified case.

I. Real Party in Interest (37 C.F.R. § 41.37(c)(1)(i))

The real party in interest in the present appeal is Texas Instruments Incorporated.

II. Related Appeals and Interferences (37 C.F.R. § 41.37(c)(1)(ii))

Appellant, appellant's legal representatives, and/or the assignee of the present application are unaware of any appeals or interferences which will directly affect, or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims (37 C.F.R. § 41.37(c)(1)(iii))

Claims 1-4, 6-10, 12, 14-18, 20-24 and 26 are pending in the application. The rejection of claims 1-4, 6-10, 12, 14-18, 20-24 and 26 is appealed.

IV. Status of Amendments (37 C.F.R. § 41.37(c)(1)(iv))

No claim amendments have been entered subsequent to the final rejection.

V. Summary of Claimed Subject Matter (37 C.F.R. § 41.37(c)(1)(v))

As set forth in claims 1 and 15, and generally referring to Fig. 1, a semiconductor device 2 comprises a ferroelectric capacitor C_{FE} that includes a conductive lower electrode material 18 formed over a semiconductor body 4. A ferroelectric material 20 is formed over the lower electrode material, and a conductive lower electrode material 22 is formed thereover. (*See*, *e.g.*, applicants' specification, page 7, lines 13-29). The ferroelectric material 20 sandwiched between the lower and upper electrodes 18, 22 comprises unit cells 200 that individually comprise an elongated dimension. (*See*, *e.g.*, c-dimension, page 8, lines 17-25, Figs. 4B and 4C). In accordance with the invention of claims 1 and 15, the percentage of unit cells oriented with their elongated dimensions substantially normal to a generally planar surface of the semiconductor body 4 is about 50% or more and about 70% or less. (*See*, *e.g.*, page 9, lines 18-24).

In contrast to prior art solutions that presumed that maximizing the percentage of unit cells with elongated dimensions oriented as described was desired to maximize the switched polarization of the ferroelectric capacitor, the present invention of claims 1 and 15 advantageously identified a heretofore unappreciated design trade-off between maximized volume orientation and polarization relaxation. (*See*, *e.g.*, page 8, line 26 – page 9, line 11). Thus the invention of claims 1 and 15 recite an intermediate range of about 50-70% of unit cells oriented as described, and such feature was found to exhibit improved data retention by achieving sufficient switched polarization without significant degradation in polarization relaxation. (*See*, *e.g.*, page 9, lines 12-30, page 15, lines 4-8, and Figs. 5D and 5E).

VI. Grounds of Rejection to be Reviewed on Appeal (37 C.F.R. § 41.37(c)(1)(vi))

Claims 1-2, 7-8, 15-16 and 21-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,155,658 (Inam et al.).

Claims 3-4, 6, 9-10, 12, 14, 17-18, 20, 23-24 and 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Inam et al. in view of U.S. Application No. 2004/0173826 (Natori) or JP2003-133604 (Sumi).

VII. Argument (37 C.F.R. § 41.37(c)(1)(vii))

A. REJECTION OF CLAIMS 1-2, 7-8, 15-16 AND 21-22 UNDER 35 U.S.C. § 103(a)

Claims 1-2, 7-8, 15-16 and 21-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,155,658 (Inam et al.). Reversal of the rejection is respectfully requested for at least the following reasons.

i. Contrary to the assertion in the Office Action, the range recited in claims 1 and 15 is not obvious over Inam et al. because the claimed range does not involve routine skill in the art.

Claim 1 is directed to a semiconductor device comprising a ferroelectric capacitor having a ferroelectric material. The ferroelectric material comprises unit cells individually comprising an elongated dimension, wherein a percentage of the unit cells are oriented with the elongated dimensions substantially normal to a generally planar upper surface of the semiconductor body, ***and wherein the percentage of cells oriented in that manner is about 50% or more and about 70% or less***. The Office Action concedes that the cited reference (Inam et al.) does not teach a ferroelectric material comprising unit cells with elongated dimensions oriented as claimed in percentages of between about 50% and 70%. However, the Office Action asserts that the claim limitation is obvious in view of the cited art because it would have been obvious to meet the recited working ranges. Applicant concedes that in some limited circumstances it is not inventive to recite optimum or working ranges, however, the MPEP unambiguously states that when a particular range is critical, a prima facie case

of obviousness is rebutted. MPEP §2144.05 (III) (*citing* In re Woodruff, 919 F.2d 1575 (Fed. Cir. 1990)).

It is respectfully submitted that the recited range in the above claim is critical and nonobvious over the cited art. ***As set forth in applicants' specification, for example, on page 8, line 26 – page 9, line 11, the inventors of the present invention discovered and appreciated that a trade-off exists in ferroelectric capacitor performance.*** For example, while an increased volume orientation improves switched polarization, ***at substantially high levels of volume orientation it was discovered that after programming, the capacitor tends to relax to a lower polarization level. Consequently, the inventors of the present invention discovered that ferroelectric material with volume orientation approaching 100% undesirably leads to large relaxation levels, thereby negatively impacting sense margin***.

Further, the inventors of the present invention found that ***at an intermediate range of volume orientation (50% to 70%, as recited in claims 1 and 15), the advantages of improved data retention and switched polarization are obtained without a significant degradation in polarization relaxation***. (*See, e.g.*, applicants' specification, page 9, lines 12-30 and Fig. 5D). ***Thus the use of an intermediate range of volume orientation as claimed achieves unexpected results by reducing polarization relaxation.*** Therefore contrary to the assertions in the Office Action, the range recited in the present invention is not a mere design choice, but rather is a function of the inventors' discovery. Therefore due to the unexpected results provided by the claimed range of the present invention, applicants rebut the prima facie case of obviousness asserted in the Office Action. Thus the claims at issue are nonobvious over Inam et al., and a reversal of the rejection is respectfully requested.

ii. A prima facie case of obviousness is further rebutted in the present case because the cited art teaches away from the claimed invention.

The Federal Circuit has held that a prima facie case of obviousness may be rebutted by a showing that the art, *in any material respect*, teaches away from the claimed invention. In re Geisler, 116 F.3d 1465, 1471 (Fed. Cir. 1997) (Emphasis

added), MPEP § 2144.05 (III). It is respectfully submitted that not only does Inam et al. not teach the range in question (about 50% to about 70%), but ***one of ordinary skill in the art, upon evaluating Inam et al., would not have been motivated to experiment with differing ranges (as asserted in the Office Action), because such variations were discouraged by the cited art***. More particularly, Inam et al. encourage a ***maximization*** of the c-axis orientation. For example, in Col. 4, lines 21-23 of Inam et al., it states: "[f]or a good ferroelectric memory, the c-axis orientation should be increased to above 80% and preferably about 90%.") ***Thus one of ordinary skill in the art would not be motivated to reduce the c-axis orientation to an intermediate range as claimed, but rather would attempt to maximize the c-axis orientation based upon the teaching of Inam et al.*** For at least this additional reason, the claims at issue are nonobvious over Inam et al. Accordingly, reversal of the rejection is respectfully requested for this additional reason.

iii. The Office Action of June 30, 2005 incorrectly employs applicants' own disclosure as motivation to modify the Inam et al. reference.

In responding to applicants' arguments, the Office Action of June 30, 2005 asserts that because applicants' specification discloses a range of 50-90%, one of ordinary skill in the art would be motivated to modify Inam et al.'s range of <80% in accordance with applicants' claims. Applicants respectfully submit that use of applicants' specification as motivation in modifying a cited reference is inappropriate.

In addition, while applicants' specification does indeed state that a range of 50-90% can provide acceptable performance, applicants' specification clearly and unambiguously notes that the claimed range of 50-70% provides optimized performance and performance advantages over the prior art. (*See, e.g.*, page 9, lines 18-24). Therefore the claimed invention provides for a significant improvement over the prior art by appreciating a heretofore unknown performance trade-off, and thus countenances a counter-intuitive volume orientation range. For at least the above reasons, the claimed invention is believed to be non-obvious over the cited art. Accordingly, a reversal of the rejection is respectfully requested.

B. REJECTION OF CLAIMS 3-4, 9-10, 12, 14, 17-18, 20, 23-24 AND 26 UNDER 35 U.S.C. § 103(a)

Claims 3-4, 9-10, 12, 14, 17-18, 20, 23-24 and 26 were rejected under 35 U.S.C. § 103(a) as being obvious over Inam et al. in view of U.S. Application No. 2004/0173826 (Natori) or JP2003-133604 (Sumi). A reversal of the rejection is respectfully requested for at least the following reasons.

i. The combination of Inam et al. with either Natori or Sumi is improper because the requisite motivation for such combination does not exist.

Claims 4, 10, 12, 18, 24 and 26 each recite that the lower electrode material comprises iridium. The Office Action concedes that Inam et al. do not teach this feature, but asserts that it would be obvious to combine Inam et al. with either Natori or Sumi to arrive at the claimed invention. Applicants respectfully disagree.

As set forth in MPEP § 2143.01, motivation to combine or modify references can be found in the art itself, in the general knowledge of those skilled in the art, or in the nature of the problem to be solved. However, the Federal Circuit has stated that ***if a proposed modification would render the prior art being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification***. MPEP § 2143.01 (*citing* In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)). It is respectfully submitted that upon a proper evaluation of the Inam et al. reference, no motivation to modify the cited art in accordance with the secondary references exists.

Inam et al. disclose electrode materials that have orthorhombic-type crystal structures. (*See, e.g.*, Table in Col. 3, and Col. 3, line 60 – Col. 4, line 6). This electrode material is not arbitrary, but rather is selected to maximize the c-axis orientation of the PZT material subsequently grown on the lower electrode. As set forth in Inam et al., the goal of the reference is to maximize the c-axis orientation. (*See, e.g.*,

Col. 4, lines 20-23). ***Therefore one of ordinary skill in the art would not be motivated to replace the cuprate oxide (YBCO) material with iridium because doing so would result in reduced c-axis orientation in the PZT, and thus would frustrate a central purpose of Inam et al.*** Accordingly, the combination is improper because the requisite motivation to make the combination does not exist.

CONCLUSION

For at least the above reasons, the claims currently under consideration are believed to be patentable over the cited references. Accordingly, it is respectfully requested that the rejections of the pending claims be reversed.

For any extra fees or any underpayment of fees for filing of this Brief, the Commissioner is hereby authorized to charge the Deposit Account Number 20-0668, TI-37151.

Respectfully submitted,
ESCHWEILER & ASSOCIATES, LLC

Thomas G. Eschweiler
Registration No. 36,981

National City Bank Building
629 Euclid Ave., Suite 1210
Cleveland, Ohio 44114
(216) 502-0600

CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Date: December 20, 2005

Christine Gillroy

Christine Gillroy

VIII. Claims Appendix (37 C.F.R. § 41.37(c)(1)(viii))

1. (Previously presented) A semiconductor device, comprising:

a ferroelectric capacitor comprising:

a conductive lower electrode material formed above a semiconductor body;

a ferroelectric material formed above the lower electrode material, the ferroelectric material comprising unit cells individually comprising an elongated dimension, wherein a percentage of the unit cells are oriented with elongated dimensions substantially normal to a generally planar upper surface of the semiconductor body, and wherein the percentage is about 50% or more and about 70% or less; and

a conductive upper electrode material formed above the ferroelectric material.

2. (Original) The device of claim 1, wherein the ferroelectric material comprises PZT.

3. (Original) The device of claim 2, wherein the percentage is about 60% or more and about 70% or less.

4. (Original) The device of claim 2, wherein the lower electrode material comprises Iridium.

5. (Canceled).

6. (Original) The device of claim 2, wherein the unit cells of the ferroelectric material have a tetragonal distortion of about 1% or more and about 4% or less.

7. (Original) The device of claim 2, wherein the PZT ferroelectric material comprises a Zr content of about 0-52%.

8. (Original) The device of claim 7, wherein the PZT ferroelectric material comprises a Zr content of about 10-40%.

9. (Original) The device of claim 1, wherein the percentage is about 60% or more and about 70% or less.

10. (Original) The device of claim 9, wherein the lower electrode material comprises Iridium.

11. (Canceled).

12. (Original) The device of claim 1, wherein the lower electrode material comprises Iridium.

13. (Canceled).

14. (Original) The device of claim 1, wherein the unit cells of the ferroelectric material have a tetragonal distortion of about 1% or more and about 4 % or less.

15. (Previously presented) A ferroelectric capacitor comprising:

a conductive lower electrode material formed above a semiconductor body;

a ferroelectric material formed above the lower electrode material, the ferroelectric material comprising unit cells individually comprising an elongated dimension; and

a conductive upper electrode material formed above the ferroelectric material;

wherein the upper and lower electrodes are spaced from one another along an axis, wherein a percentage of the unit cells in the ferroelectric material are oriented with elongated dimensions substantially parallel to the axis, and wherein the percentage is about 50% or more and about 70% or less.

16. (Original) The ferroelectric capacitor of claim 15, wherein the ferroelectric material comprises PZT.

17. (Original) The ferroelectric capacitor of claim 16, wherein the percentage is about 60% or more and about 70% or less.

18. (Original) The ferroelectric capacitor of claim 16, wherein the lower electrode material comprises Iridium.

19. (Canceled).

20. (Original) The ferroelectric capacitor of claim 16, wherein the unit cells of the ferroelectric material have a tetragonal distortion of about 1% or more and about 4% or less.

21. (Original) The ferroelectric capacitor of claim 16, wherein the PZT ferroelectric material comprises a Zr content of about 0-52%.

22. (Original) The ferroelectric capacitor of claim 16, wherein the PZT ferroelectric material comprises a Zr content of about 10-40%.

23. (Original) The ferroelectric capacitor of claim 15, wherein the percentage is about 60% or more and about 70% or less.

24. (Original) The ferroelectric capacitor of claim 23, wherein the lower electrode material comprises Iridium.

25. (Canceled).

26. (Original) The ferroelectric capacitor of claim 15, wherein the lower electrode material comprises Iridium.

27-50. (Canceled).

IX. Evidence Appendix (37 C.F.R. § 41.37(c)(1)(ix))

No additional evidence not already part of the official record is relied upon in the arguments provided herein.

X. Related Proceedings Appendix (37 C.F.R. § 41.37(c)(1)(x))

Not applicable.

PTO/SB/17 (12-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($) 500.00

Complete if Known	
Application Number	10/797,503
Filing Date	March 10, 2004
First Named Inventor	Glen R. Fox et al.
Examiner Name	Ahmed N. Sefer
Art Unit	2826
Attorney Docket No.	TI-37151

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☑ Other (please identify): Deposit Account

☑ Deposit Account Deposit Account Number: 20-0668 Deposit Account Name: Texas Instruments Incorporated

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	Fee ($)	Small Entity Fee ($)	Fee ($)	Small Entity Fee ($)	Fee ($)	Small Entity Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 20 or HP =	_____	x 50.00	= _____

HP = highest number of total claims paid for, if greater than 20

Indep. Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 3 or HP =	_____	x 200.00	= _____

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims	Fee ($)	Fee Paid ($)
	_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee ($)	Fee Paid ($)
_____ - 100 =	_____ / 50 =	_____ (round up to a whole number)	x _____	= _____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other: Filing a Brief in Support of an Appeal	500.00

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 36,981	Telephone (216) 502-0600
Name (Print/Type)	Thomas G. Eschweiler		Date 12/20/05